

# **Planet Labs Dove 3/4 Data Protection Plan (DPP)**

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## Revision History

Rev.	Date	Affected Pages	Description of Change	Author(s)
1.0	5/15/12	ALL	Initial Release	Chris Boshuizen
2.0	2/15/13	ALL	Addition of Half Moon Bay and UK ground station. Description of limited initial data distribution	Michael Safyan
3.0	2/21/13	ALL	Addition of Kentucky ground station, clarification of ground network	Michael Safyan
4.0	4/10/13	11,12	UK ground station hardware export granted, Clarification of server closet security	Michael Safyan
4.1	4/13/13	6	Resolution expressed in GSD	Michael Safyan
4.2	6/26/13	ALL	Corporate name changed to Planet Labs Inc.	Michael Safyan

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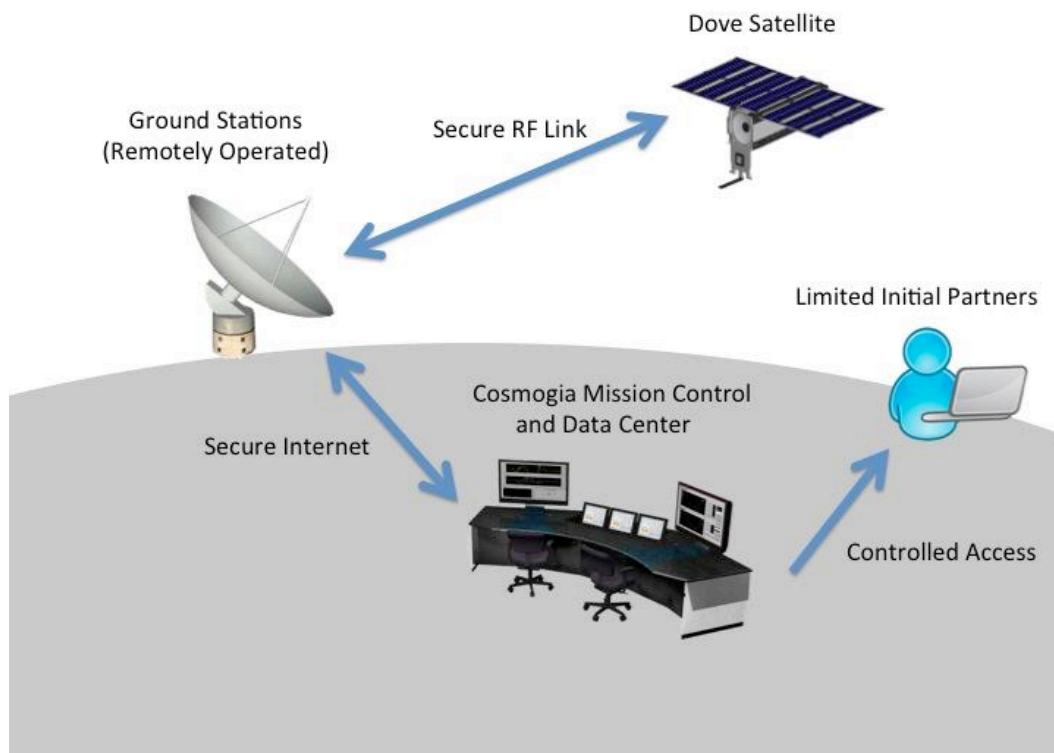
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## A. Data Protection Plan End-to-end Summary

### 1. High level description of the overall data protection strategy

Planet Labs' Dove 3/4 satellite mission is an internal company technology demonstration experiment. The Dove 3 and Dove 4 satellites are nearly identical, and will be deployed into slight different orbits from the same launch vehicle. This experiment will be used for incremental technology development towards future commercial remote sensing capabilities. Dove 3/4 data will not be publicly available, but sample imagery may be used for marketing material or collaboration purposes with early commercial or U.S. government partners. This data protection strategy includes implementing standard encryption protocols for data transfer paths, securing Planet Labs facilities and partner organization facilities, and limited data distribution to trusted partners.

### 2. Flow diagram of the entire data protection process



### 3. Description of the end-to-end data protection process

### High Level Description

The main method of protecting data links is through utilization of industry standard encryption techniques. Telemetry and Command links will be protected using AES-256-CTR, imagery data will be protected using SSH AES-128, and data links between ground centers will be protected using SSH AES-256. Only Planet Labs personnel will have access to these links, which will require VPN authentication and password protection to be accessed.

At all ground station sites, TT&C communications will be operated remotely from the Planet Labs headquarters in San Francisco, CA. Any on-site personnel at a ground station site, either employed by Planet Labs or by the host organization, will be operating the physical movements of the antennas, but not the communications link. Physical access to ground station radio equipment will be restricted to Planet Labs Personnel through the use of a locked, non-transparent enclosure and software access will be restricted by VPN authentication and password protection. VPN Authorization is controlled by a white list of approved users.

Transfer of data between ground stations and Planet Labs Headquarters in San Francisco, CA, which will act as Mission Control and Data Analysis Center will be through an SSH connection with AES-256 encryption.

### Storage system security

All Planet Labs data storage devices will include, at a minimum, AES-128 data encryption, BitLocker disk-level protection or equivalent, and password protection.

### Backup and Recovery

At Planet Labs Headquarters, data will be regularly backed up on Planet Labs server storage and external media (DVDs) located at the company San Francisco, CA offices.

### Facility security

Planet Labs' San Francisco office is secured by an external gate, a card access system and a front door electronic key card system. All Planet Labs computers and networks are password protected and/or with BitLocker disk-level encryption. The main computer server and disk storage array are in a server room behind an additional locked door. An ADT security system logs all employee entry in to the offices, and automatically reports unauthorized entries.

The Palo Alto site is operated by SRI International, and the facility includes gated access controls to the road, an additional security gate at the antenna site, and a locked office at the ground station controls. The SRI site has been used for governmental and commercial satellite operations in the past.

The Morehead site is operated by Morehead State University, and the facility includes gated access controls to the road, an additional security gate at the antenna site, and a locked office at the antenna controls. The Morehead site has been used for satellite operations in the past.

The Half Moon Bay site is hosted on Globe Wireless' facility, which is enclosed in fencing and has a

manned security gate for access to the site. The Globe Wireless site is an active, secure facility for maritime communications and commercial cell tower hosting.

The Chilbolton Observatory site is operated by STFC RAL Space and controlled either from: a) a lockable room inside an access controlled on-site building, or b) a lockable room inside the access controlled STFC facility in Harwell, UK. The Chilbolton site has been used by governmental and commercial satellite operations in the past.

#### Restriction on collection

Any governmental and regulatory restrictions on collection of imagery will be observed through the addition of imaging exclusion zones to the satellite tasking orders.

#### Restriction on distribution

As this is an internal company technology demonstrator and will be used by Planet Labs, its shareholders, and potential collaborators for system verification. Low resolution, non-sensitive, imagery may eventually be presented on the Planet Labs website or on printed marketing material. Planet Labs will not sell the data.

## **B. Program Space Segment**

### **1. Orbital Information (altitude, inclination, etc.)**

The Dove 3/4 mission will launch to low Earth orbit (LEO) aboard the Dnepr launch vehicle, currently planned for late-November 2013. The nominal orbit for Dove 3 is 800 x 597 km at an inclination of 97.8°, and for Dove 4 is 700 x 700 km at an inclination of 97.8°.

### **2. Sensor type, basic design features, and scanning mechanism descriptions**

The instrument includes a Kodak's KAI-11002 CCD sensor. The KAI-11002 is an RGB progressive scanning interline scanner producing three-color (RGB), 2-dimensional images. The camera focal array has a full resolution of 4032 x 2688 (< 11 "mega pixels") with an output format of mono or color 8, 10, 12 bit output. The best theoretical GSD of the camera system for both Dove 3 and Dove 4 is 5.36 m. The camera has a standard wide-band Bayer-mask RGB filter and a spectral range of 300-900 nm.

### 3. Top-level platform properties

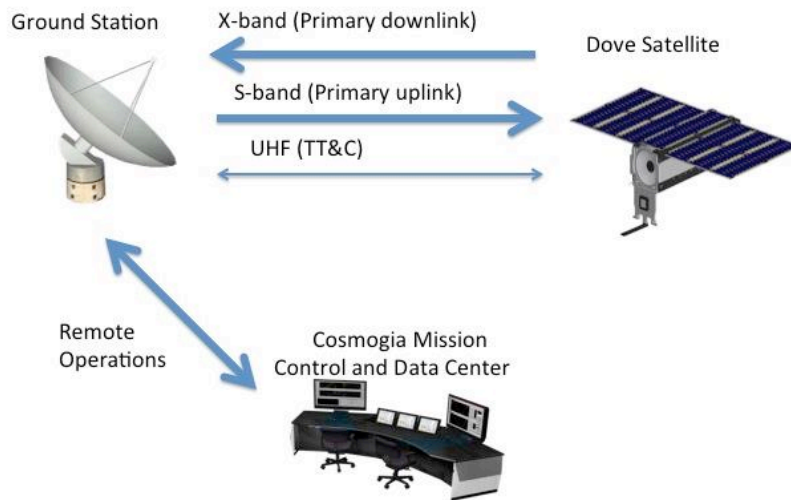


Figure 1 Dove 3/4 with solar arrays deployed

Dove 3/4 is based on the 3U cubesat form factor and the design mass is 4.5 kg. Basic physical dimensions in the stowed configuration are 100mm x 100mm x 340mm. When the foldout solar arrays are deployed, the satellite has dimensions of 100mm x 700mm x 340mm. The Dove 3/4 structure is custom-built by Planet Labs and consists of a load bearing superstructure and plates on which the optical assembly, PCBs and other electronics are mounted. The optical path is down the central axis of the satellite.

Magnetometers, photo-diode based sun sensors, GPS, and star camera combining to give approximately 0.01 degrees best-case pointing knowledge. Magnetorquers and reaction wheels combine to give 1 degree best-case pointing capability. In-track FOV is 1.26 deg, Cross-track is 1.82 deg, and on-board storage capacity is 128 GB. The telescope is a Maksutov-Cassegrain type reflector, built by Questar, with a 3.5 inch (89mm) aperture and an f-ratio of f/14.6.

#### 4. General space / ground architecture



System architecture consists of a single 3U CubeSat space segment, remotely controlled ground stations, a central mission control and data center.

##### Space Segment Architecture

- Space System: Two 3U CubeSat Satellites (Dove 3 & Dove 4)
- Imaging System: Low-Earth Orbit Electro-Optical Imaging System (300-900 nm)

##### Ground Segment Architecture

- Mission Control Center: Planet Labs Headquarters, San Francisco
- Data Analysis Center: Planet Labs Headquarters, San Francisco
- Remote Controlled Ground Stations:
  - Half Moon Bay, CA
  - Morehead, KY
  - Palo Alto, CA
  - Chilbolton Observatory (UK)



## 5. Overview of the end-to-end system communications architecture

Mission Control Center (MCC) will be at Planet Labs HQ in San Francisco, CA. All mission data and telemetry will be forwarded through the remotely operated ground station sites back to the MCC at Planet Labs HQ. All command and control tasking will originate from the MCC at Planet Labs HQ and be forwarded to the satellite through the remotely operated ground station sites.

Data Type	From	To	Path	Protocol	Encryption
Mission Data	Satellite	Ground Station	X-band	DVB-S2, SSH	AES-128
Mission Data	Ground station	Data Analysis (Planet Labs HQ)	Internet	SSH	AES-256
Command & Control	Mission Control (Planet Labs HQ)	Ground station	Internet	SSH	AES-256
Command & Control	Ground station	Satellite	S-band, UHF	Serial	AES-256
Telemetry	Satellite	Ground Station	UHF	Serial	AES-256
Telemetry	Ground Station	Mission Control (Planet Labs HQ)	Internet	SSH	AES-256

## 6. RF data downlinks

### a. Link Information:

- X-band (8.2 GHz): primary payload downlink
- S-band (2.056 GHz): primary command uplink
- UHF (401.3 & 450.0 MHz): telemetry downlink, secondary command uplink

### b. Physical Characterization:

Frequency	Modulation	Bit Rate	Link Margin (dB)	Satellite Antenna	GS Antenna	Data Compression	Encryption
8.2 GHz	QPSK	5 Mbps	6	Patch	Parabolic	WebP	AES-128
2.056 GHz	MSK	500 kbps	6	Patch	Parabolic	None	AES-256
401.3 MHz	GFSK	2.4 kbps	6	Omni	Yagi	None	AES-256
450.0 MHz	GFSK	2.4 kbps	6	Omni	Yagi	None	AES-256

### c. Information types

- X-band (8.2 GHz): imagery data, imagery metadata, telemetry
- S-band (2.056 GHz): TT&C, imagery tasking, downlink schedule tasking
- UHF(401.3): TT&C, satellite health/status
- UHF (450.0 MHz): TT&C, basic tasking

\*note: all information types are encrypted as described in the table above

## US Government Tasking

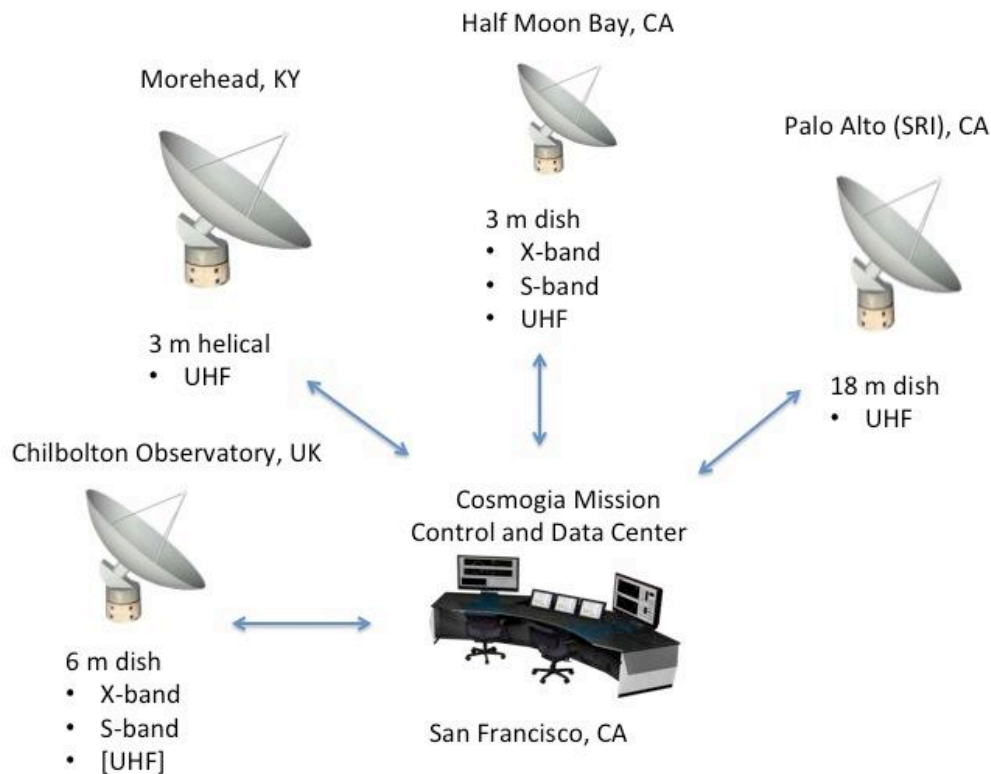
No separate tasking links exist to serve US government operations, but the satellite is capable of receiving tasks that will ensure compliance with 960.11(4). Any tasking of the system required by any USG agency will be kept in a separate, encrypted directory. This data will be stored only in the Planet Labs San Francisco office, on local media, and secured in a locked room.

## Imagery Process Overview

The camera uses a Bayer Mask in front of its CCD in the standard RGGB arrangement. The image data is collected from the camera as an array of pixels, each of 12 bit depth. Planet Labs satellite software then uses industry standard interpolation techniques to construct an RGB image and store it as a BMP file. During this step, the color depth is also truncated to 8 bits per channel. The data from the BMP file is then compressed to the WebP format. Depending on where the satellite is over Earth, the image may be spatially down sampled to produce a lower spatial resolution image that is smaller in size. The WebP data is considered the payload data and is nominally the only data sent to the ground. Select raw imagery will be stored on the satellite for up to 3 days for download, if needed. Each image is tagged with three broad categories of metadata: camera, compression, and attitude/position metadata. The camera metadata includes parameters such as exposure time and gain. The compression metadata includes compression type and quality level. The attitude and position metadata includes a time stamp, orbital position estimation and satellite orientation estimation.

## C. Program Ground Architecture Segment

### 1. Communications architecture



The MCC at Planet Labs HQ in San Francisco remotely operates all 4 antenna locations. Data is piped through the 4 antenna locations between the satellite and MCC over secure internet connection. The Palo Alto location has UHF communication capability. The Half Moon Bay location has X-band, S-band and UHF communication capability. The Morehead location has UHF capability. The Chilbolton location will have X-band, S-band and UHF communication capability, as approved by DDTC<sup>1</sup>.

### 2. Ground station locations

Location: Palo Alto, CA  
 Lat/long: 37.4, -122.174  
 Owner: SRI International

<sup>1</sup> DDTC case number 50432954, TA-0355-13 for the TAA and DDTC case number 730042754 for the DSP-73 temporary export of hardware

Operator: SRI International

Contact: Michael Cousins 650-859-3341, [michael.cousins@sri.com](mailto:michael.cousins@sri.com)

Location: Half Moon Bay, CA

Lat/long: 37.38, -122.41

Owner: Globe Wireless

Operator: Planet Labs

Contact: Ken Jones 650-859-3341, [ken.jones@globewireless.com](mailto:ken.jones@globewireless.com)

Location: Morehead, KY

Lat/long: 38.2, -83.4

Owner: Morehead State University

Operator: Morehead State University

Contact: Ben Malphrus 606-783-2212, [b.malphrus@moreheadstate.edu](mailto:b.malphrus@moreheadstate.edu)

Location: Chilbolton Observatory, UK

Lat/long: 51.14, -1.44

Owner: STFC RAL Space

Operator: Cosmogia UK

Contact: Trevor Dimbylow +44 (0)1235 445827, [trevor.dimbylow@stfc.ac.uk](mailto:trevor.dimbylow@stfc.ac.uk)

### **3. Personnel and Ground Station security measures**

Planet Labs has a policy to conduct background checks for all new employees and contractors, both US citizens and foreign nationals. Planet Labs also has ITAR controlled technology which is managed through an Export Control Plan. All company data is in the unclassified domain. Foreign nationals working on export restricted (ITAR) materials have the appropriate export licenses obtained via the DSP-5 application.

All employees and contractors have a key to the Planet Labs San Francisco building gate, a keycard to access the building and a key to access Planet Labs offices. All guests are able to enter the building during business hours and enter Planet Labs offices to a reception desk where they will be required to check in and sign a guest log book. All guests are escorted beyond the reception area. Foreign National guests are issued a badge, clearly marking them as Foreign Nationals, and are contained in areas of the facility that are free of ITAR controlled hardware. In addition to this, there is a server closet under an additional lock and key which houses Planet Labs' secure fileserver and archived data. Only the appointed Planet Labs IT Security Manager has access to the server closet, which requires a physical key for the door handle and deadbolt.

Planet Labs has a contract to use the ground station owned and operated by Stanford Research Institute (SRI) located on Stanford University campus in Palo Alto, CA. There is controlled access to the road which leads to the security gate around the ground station. This security gate is under lock and key and so is the office.

Planet Labs has a contract to use the ground station owned and operated by Morehead State University located on campus in Morehead, Kentucky. There is controlled access to the road which leads to the security gate around the ground station. This security gate is under lock and key and so is the office

Planet Labs has contracted Globe Wireless to host a Planet Labs ground station antenna at their Half Moon Bay site. There is a controlled access gate to the site and on-site personnel during operating hours.

Cosmogia UK Ltd.<sup>2</sup>, a wholly owned subsidiary, has installed Planet Labs radio equipment on existing antenna assets owned by STFC RAL Space located at Chilbolton Observatory in the UK. Installed ground station equipment has been placed in a locked enclosure and is monitored by Cosmogia UK staff.

#### **4. Protection of uplink, downlink and data transfer links, processing and distribution flow.**

- An SSH server on the satellite will provide 128-bit AES encryption over the S-band satellite link and a custom serial protocol with 128-bit AES level encryption over the UHF satellite link
- SSH 256-bit AES encryption will be used on all ground-to-ground data transfer links.

To insure the integrity of the system's operation, the following plans are in place:

- Positive Control of the Satellite: will be maintained through the S-band and UHF uplinks
- Unauthorized access: will be restricted by (1) password protection, (2) downlinking only over specified ground stations by time slots, (3) secure communications using SSH, (4) personnel security measures, and (5) physical security measures.
- Restriction on collection: any restrictions to collection will be observed through uploading updated timetables for picture capture mode scheduling. In this way the camera will remain unpowered in restricted regions.
- Restriction on Distribution: no data will be distributed.

#### **5. USG Agency Tasking**

Any tasking of the system required by any USG agency will be kept in a separate, encrypted directory. This data will be stored only in the Planet Labs San Francisco office, on local media, and secured in a locked room.

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<sup>2</sup> The corporate name Cosmogia UK Ltd. will eventually also be changed, but for now remains the same.